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Comparison of a designed virtual oscilloscope with a real oscilloscope

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Abstract. A virtual oscilloscope based on LabVIEW software was designed. Sinus, square and triangle shaped signals produced by a function generator were analyzed with a real and a virtual oscilloscope. Amplitude, rise time and fall time values of a signal were determined for different time/division values in both type oscilloscopes. Obtained values in the virtual oscilloscope were compared with those of the real oscilloscope. It was deduced from the results that amplitude, rise time and fall time values and signal shapes were compatible with each other.

1 Introduction

LabVIEW, Laboratory Virtual Instrument Engineering Workbench, is a programming environment in which programs are created by using a graphical notation. It is based on graphical programming. LabVIEW software can command plug-in data acquisition devices to acquire or generate signals. It also facilitates data transfer over a GPIB (General Purpose Interface Bus) or a serial port [1]. Its graphical nature makes it ideal for test and measurement, instrument control, data acquisition and data analysis applications [2].

An oscilloscope is a voltage sensitive electronic instrument that is used to visualize certain voltage signals. An oscilloscope can display the variation of a voltage signal in time on the oscilloscope's screen [3]. Time and amplitude values of the signal can be determined by means of the oscilloscope.

A virtual instrument consists of a computer, a software and a hardware. They are combined and configured to emulate the function of traditional hardware instrumentation. Virtual instruments are extremely flexible, powerful and cost-effective [1].

An oscilloscope can be used for amplitude, rise time and fall time measurements of a signal. The amplitude is the height of a pulse in volt unit as measured from its maximum value to its instantaneous baseline. The rise time is the time it takes for the pulse to rise from 10 to 90% of its full amplitude. The fall time is the time it takes for the pulse to fall from 90 to 10% of its full amplitude [4].

Since a virtual oscilloscope which is a kind of virtual instruments can be developed by LabVIEW software, it was designed through the program in this study. Sinus, square and triangle shaped signals were analyzed with a real and a virtual oscilloscope. Amplitude, rise time and fall time values of the signals obtained from the real and virtual oscilloscopes were compared. According to the obtained results, the virtual oscilloscope was in highly compatible with the real oscilloscope in terms of amplitude and time measurements and the signal shapes.

2 Material and methods

In this study, a GW Instek 2204 type oscilloscope as a real oscilloscope and a Hung Chang sweep function generator (9205C) as a signal source were used. Block diagram for the measurement is shown in Figure 1.

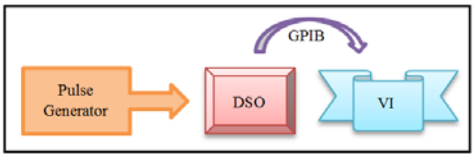

Figure 1. Block diagram for the measurement. (DSO: Digital Storage Oscilloscope, VI: Virtual Instrument, GPIB: General Purpose Interface Bus).

As can be seen in the block diagram, after sinus, triangle and square signals which were selected alternately from the function generator were displayed in the real oscilloscope; they were transferred from the real oscilloscope to the virtual oscilloscope by GPIB connection. Time/division values ranged from 1 μs to 250 μs of the real and the virtual oscilloscopes were analyzed. During the measurement, volt/division value of each oscilloscope was kept steady on 2V. Frequency of the function generator was set about 155 kHz for the 1.0, 2.5, 5.0 and 10 μs time/division values. Since the signals stayed out of the oscilloscope screen for the 25, 50, 100 and 250 μs time/division values, its frequency was decreased about to 13 kHz. In both oscilloscopes, time/division values were switched separately, and then amplitude, rise time and fall time values of the signals were determined.

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For 25 µs time/division value, as an example, signal images obtained from the virtual and the real oscilloscope are shown in Fig. 2.

Sinus signal was first selected from the generator. Amplitude, rise time and fall time values of the signal versus different time/division values ranging from 1.0 µs to 250 µs are given in Table 1.

Triangle signal was secondly used. Obtained data from the real and the virtual oscilloscopes are presented in Table 2.

Finally, the square signal was displayed in the virtual and the real oscilloscopes, and the data from the oscilloscopes can be seen in Table 3.

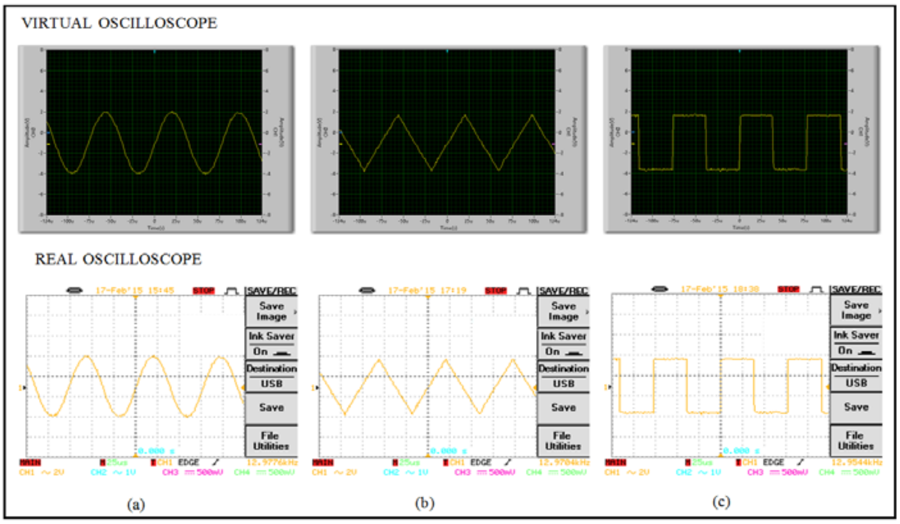

Figure 2. (a) Sinus, (b) triangle and (c) square signal shapes for 25 µs time/division in the virtual oscilloscope and the real oscilloscope.

Table 1. Amplitude (V_{amp}), rise time (T_R) and fall time (T_F) values for the sinus signal in the real and the virtual oscilloscopes.

Time/Division(µs)	Real Oscilloscope			Virtual Oscilloscope		
	V_{amp} (V)	T_R (µs)	T_F (µs)	V_{amp} (V)	T_R (µs)	T_F (µs)
1.0	5.760	1.824	1.772	5.760	1.824	1.772
2.5	5.760	1.883	1.800	5.760	1.883	1.800
5.0	5.760	1.864	1.799	5.759	1.864	1.798
10.0	5.760	1.938	1.929	5.760	1.938	1.929
25.0	5.680	21.750	20.860	5.681	21.750	20.870
50.0	5.840	21.810	21.980	5.840	21.820	21.990
100.0	5.760	21.330	22.300	5.760	21.340	22.300
250.0	5.840	24.240	23.990	5.840	24.250	23.990

Table 2. Amplitude (V_{amp}), rise time (T_R) and fall time (T_F) values for the triangle signal in the real and the virtual oscilloscopes.

Time/Division(µs)	Real Oscilloscope			Virtual Oscilloscope		
	V_{amp} (V)	T_R (µs)	T_F (µs)	V_{amp} (V)	T_R (µs)	T_F (µs)
1.0	4.960	2.388	2.424	4.960	2.388	2.424
2.5	3.840	1.871	1.927	3.840	1.871	1.927
5.0	5.120	2.504	2.431	5.120	2.504	2.431
10.0	4.720	2.255	2.218	4.720	2.255	2.218
25.0	3.440	20.260	19.800	3.440	20.270	19.800
50.0	4.320	24.900	23.940	4.320	24.900	23.940
100.0	4.080	22.920	24.070	4.080	22.920	24.070
250.0	3.760	21.360	21.980	3.759	21.360	21.980

Table 3. Amplitude (V_{amp}), rise time (T_R) and fall time (T_F) values for the square signal in the real and the virtual oscilloscopes.

Time/Division(μs)	Real Oscilloscope			Virtual Oscilloscope		
	V_{amp} (V)	T_R (μs)	T_F (μs)	V_{amp} (V)	T_R (μs)	T_F (μs)
1.0	5.20	76.68	86.85	5.20	76.69	86.83
2.5	5.28	143.40	144.20	5.28	143.40	144.20
5.0	5.20	165.00	162.50	5.20	165.10	162.50
10.0	5.20	550.90	550.00	5.20	550.90	549.80
25.0	5.20	787.80	787.80	5.20	787.90	787.90
50.0	5.28	1625.00	1600.00	5.28	1625.00	1600.00
100.0	5.28	3200.00	3200.00	5.28	3200.00	3200.00
250.0	5.28	8123.00	8123.00	5.28	8124.00	8124.00

3 Results and discussion

Sinus, triangle and square signals from a function generator were used to compare the results from both real and virtual oscilloscopes. Amplitude, rise time and fall time values of the signals were determined from both oscilloscopes. According to the results in the Table 1, Table 2 and Table 3, amplitude, rise time and fall time values from the virtual oscilloscope were highly accorded with those of the real oscilloscope. Besides, it was observed that signal shapes in both type oscilloscopes were mostly the same as each other. It was concluded that the designed virtual oscilloscope can be used as a real oscilloscope for the determination of amplitude, rise time and fall time values.

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